Grid Scale Energy Storage:

Linchpin Technology for our Clean and Secure Energy Future

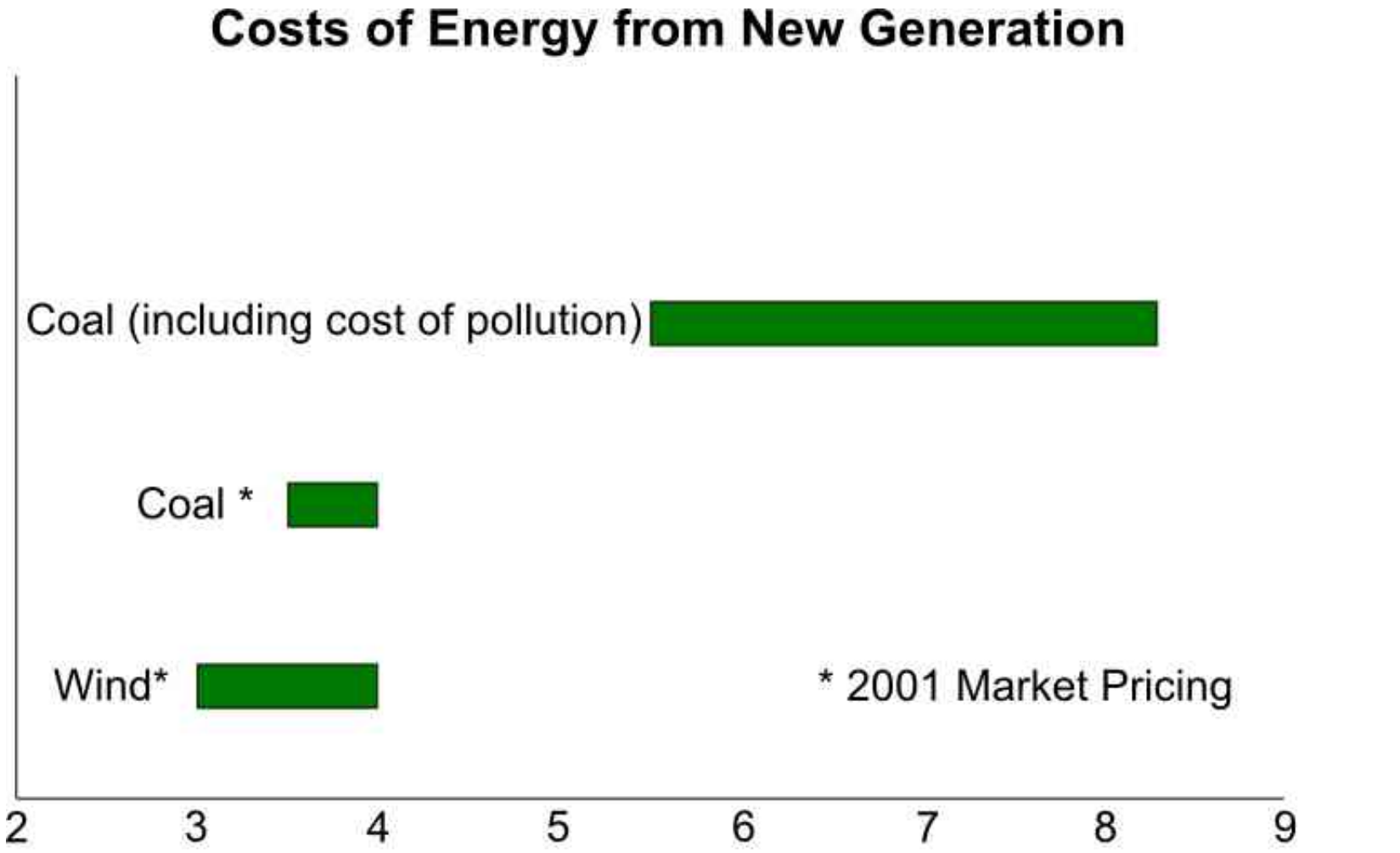
VELKESS

Kinetic Energy Storage

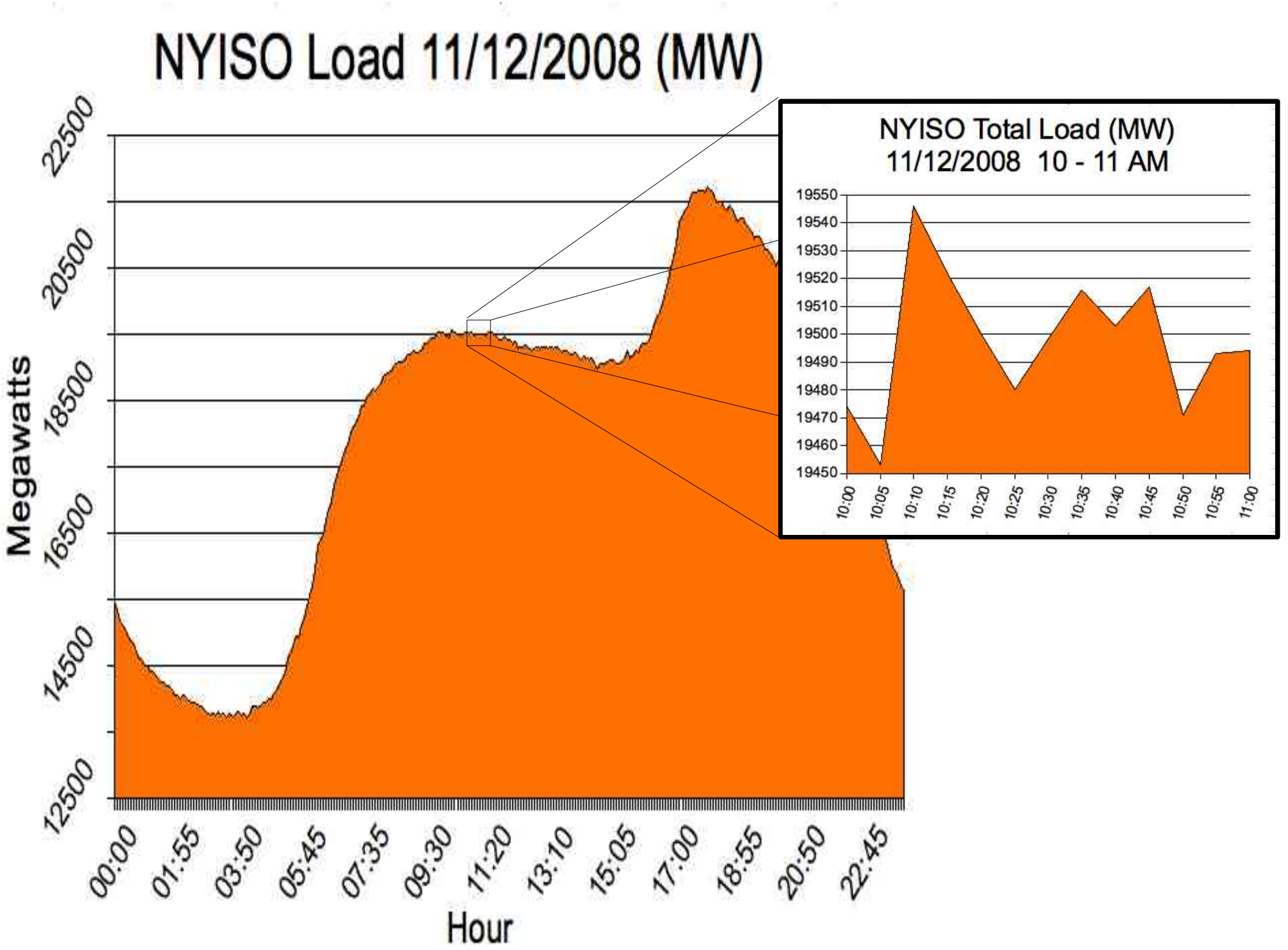
The only remaining technical and economic barrier to a 100% de-carbonized electrical system is the lack of large scale energy storage.

Allow me to explain...

Wind *IS* Cheaper than Coal!



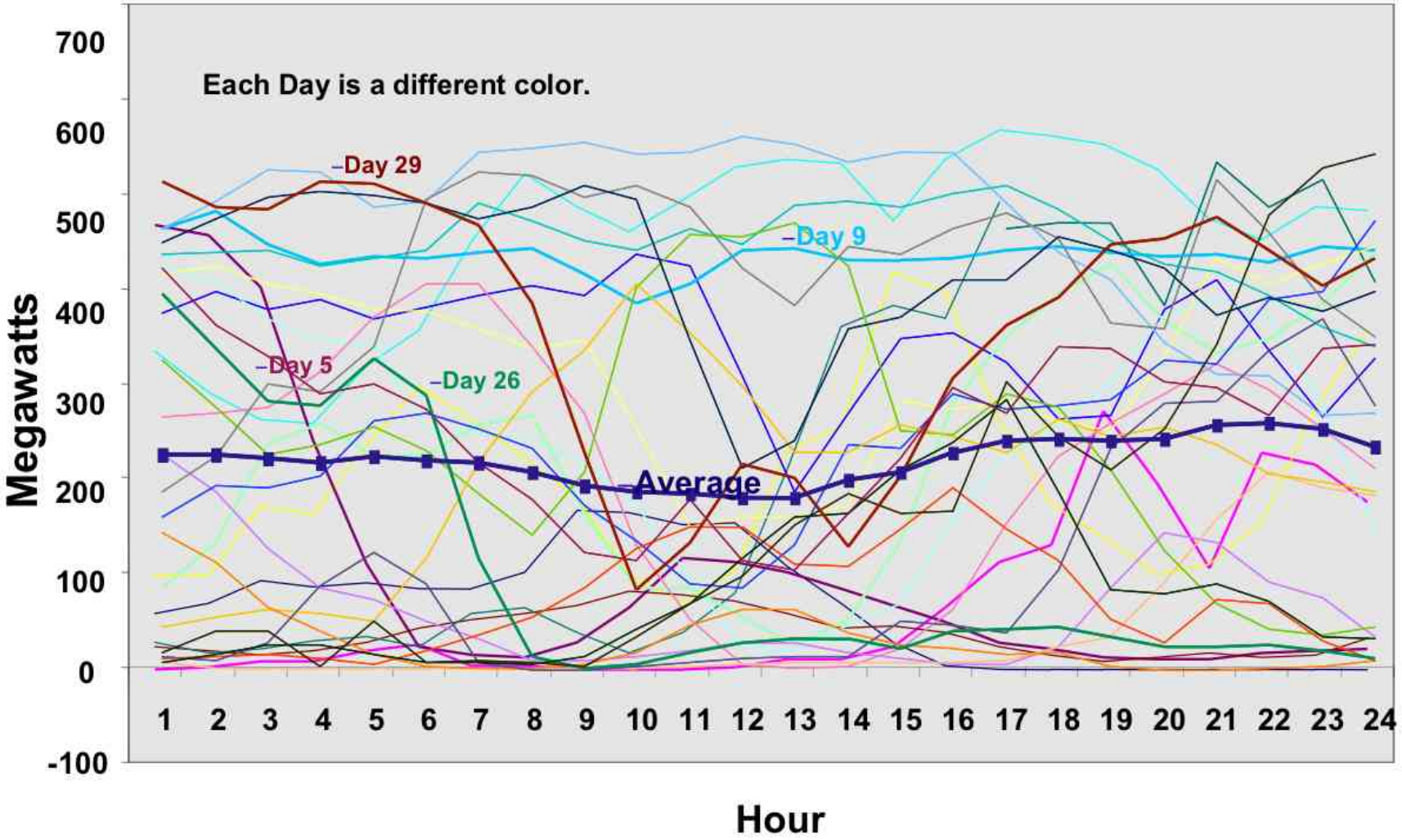
From: M. Z. Jacobson & G. M. Masters.
"Exploiting Wind Versus Coal."
Science Vol 293 (24 Aug 2001): p.1438


NYISO Load 11/12/2008 (MW)
Megawatts
22500
20500
18500
16500
14500
12500
00:00
01:55
03:50
05:45
07:35
09:30
11:20
13:10
15:05
17:00
18:55
20:50
22:45
Hour
NYISO Total Load (MW)
11/12/2008 10 - 11 AM
19550
19540
19530
19520
19510
19500
19490
19480
19470
19460
19450
10:00
10:05
10:10
10:15
10:20
10:25
10:30
10:35
10:40
10:45
10:50
10:55
11:00

You Get Wind Energy When the Wind Blows!

- Cannot Increase or Decrease Production to Meet Demand.
- Very Difficult to Predict Day Ahead or Even Hour Ahead.

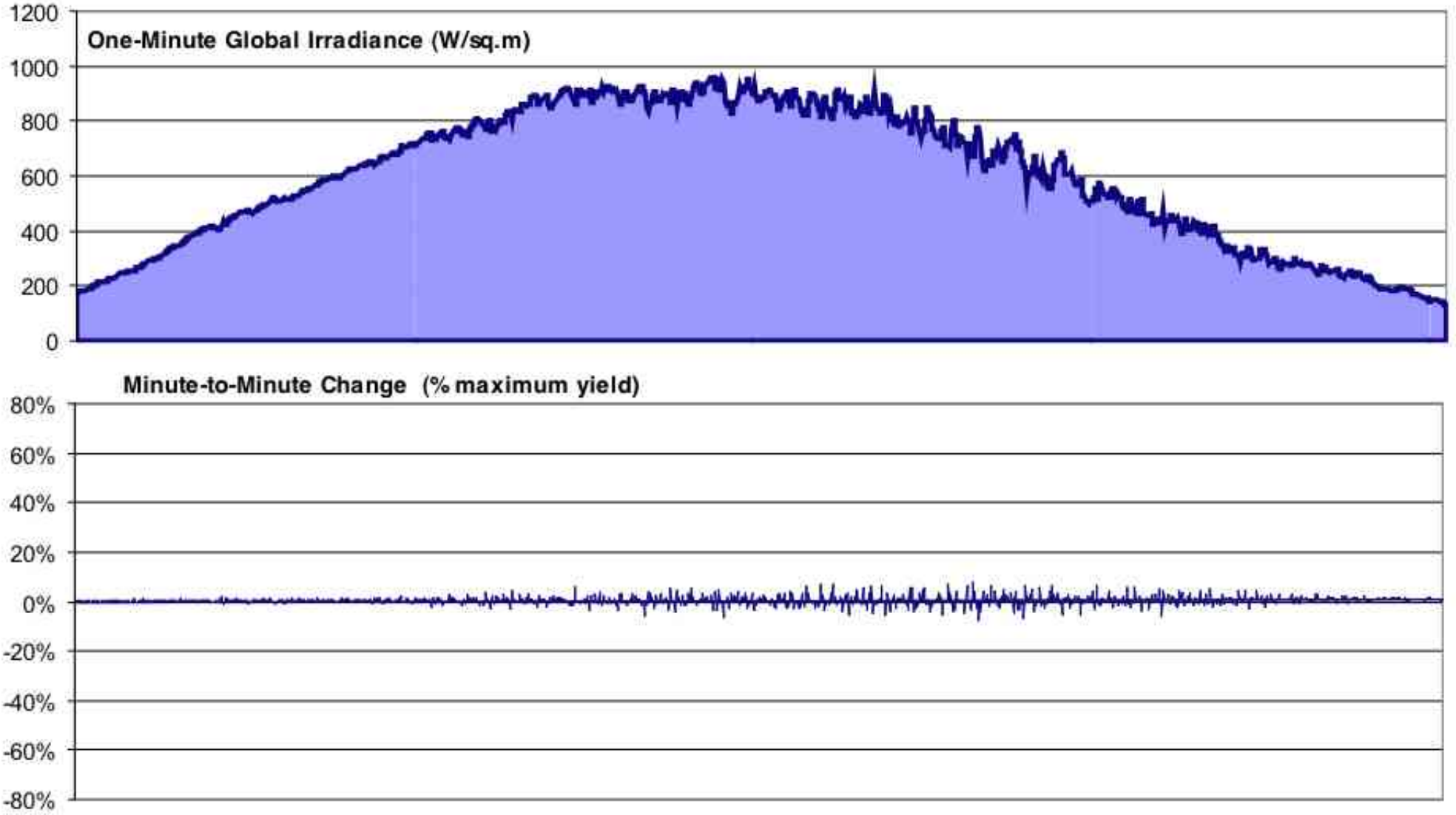
Tehachapi Wind Farm Output - April 2005



From "Briefing in the CAISO Renewables Integration Study", October 17 2007

... And You Get Solar Energy When the Sun Shines!

Actual Minute to Minute Output of Network of 20 Solar Arrays



From “Photovoltaic Capacity Valuation Methods”,
Solar Electric Power Association May 2008

“An Urban Legend:

Random Fluctuations from
Geographically Diverse Sources do ***not*** Cancel Out.

Instead:

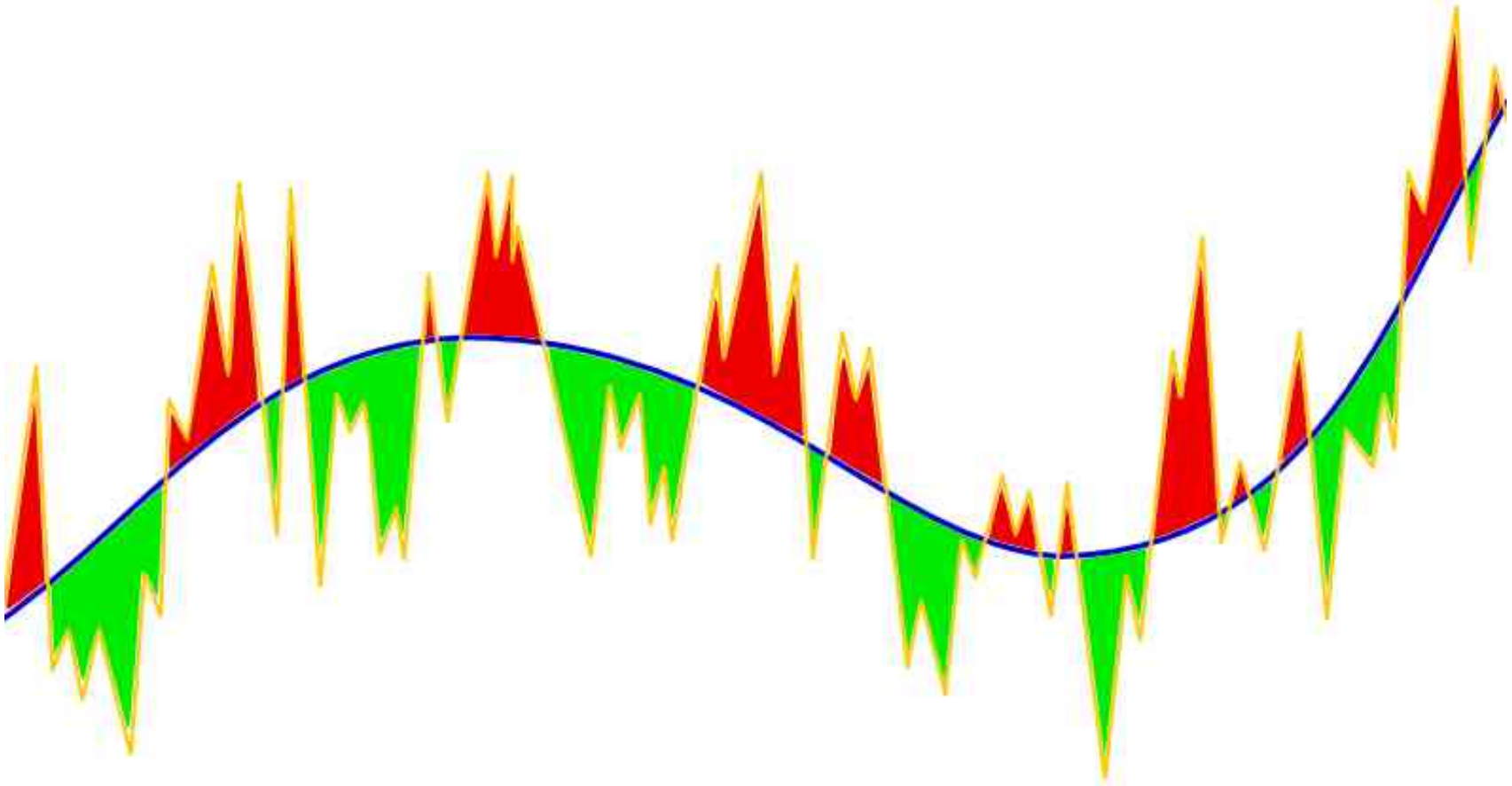
$$R = \text{sqrt} ((R_1^2 + R_2^2) / 2)$$

Noise + Noise = more Noise”

- Dr. Imre Gyuk, US Department of Energy

Grid Scale Energy Storage Will Smooth Intermittent Supply & Variable Demand...

...making 100% de-carbonization possible & profitable.



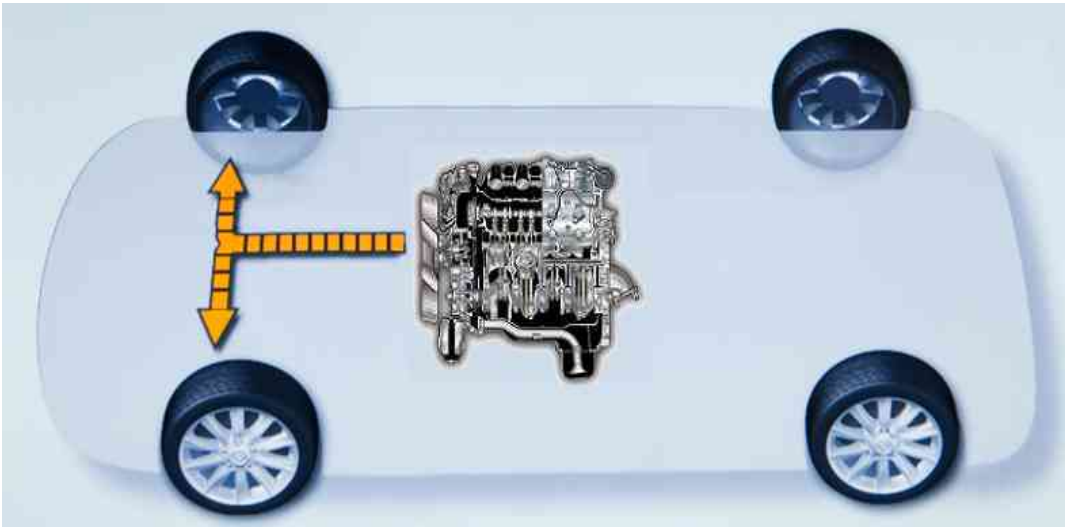
“20% renewables integration will be possible, but difficult without energy storage, and we'll have to use a whole lot of natural gas to back up the renewables. Energy storage will certainly make it a lot easier.

I can't see how it's possible to get to 33% without significant energy storage resources on the grid.”

- David Hawkins
  Lead Renewables Integration Engineer
  CAISO

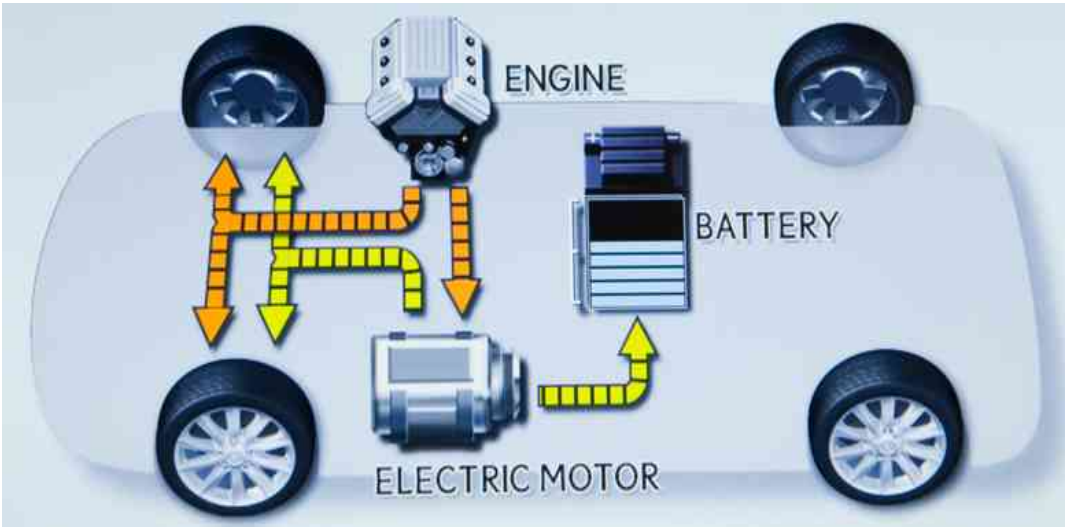
Energy Storage will also Dramatically Improve the Efficiency of Fossil Fuel Technologies

Traditional Drive-train



Energy Storage ***is*** what makes a “Hybrid” a Hybrid

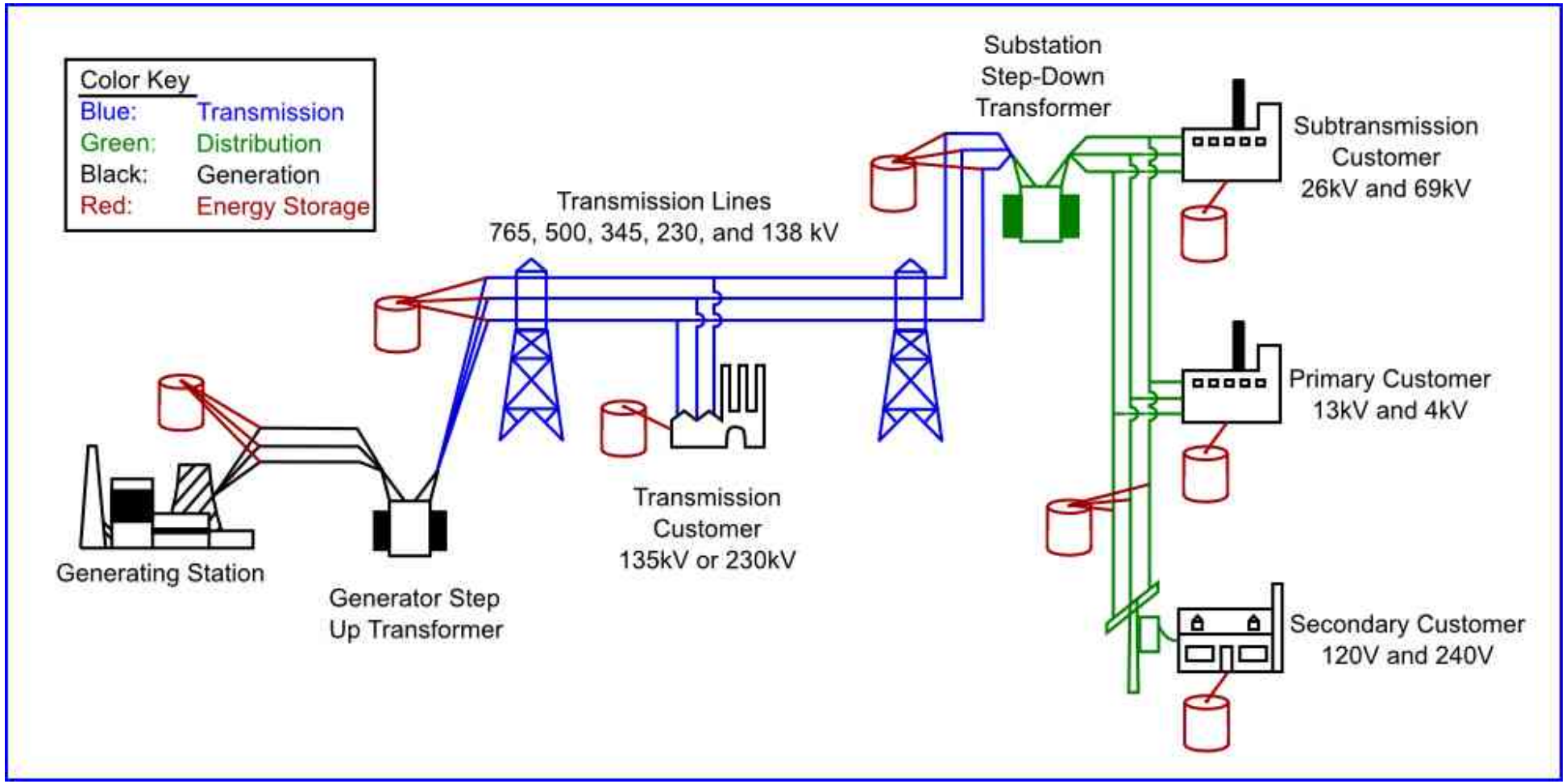
Hybrid Drive-train



Grid Scale Energy Storage will make today's Electrical System "Hybrid," just like the Toyota Prius.

Adding Energy Storage to Today's Grid will...

- **Reduce Electricity Costs**
- **Reduce Pollution**
- **Improve Power Quality**
- **Increase Available Power**
- **Increase Reliability & Energy Security**
- **Support Renewables Integration**



Adapted from "Understanding the Grid"
North American Electric Reliability Corporation
http://www.nerc.com/page.php?cid=1|15

If grid scale energy storage is so great, why isn't anyone doing it already?

A number of groups provide functional solutions...

NaS Batteries

NGK INSULATORS, LTD.

Compressed Air

Energy Storage and Power LLC

Traditional Flywheels

Beacon POWER.

Li-Ion Batteries

A123 SYSTEMS

Flowcell Batteries

ZBB energy corporation

But these currently available technologies are far too expensive to provide stored power on a large scale.

VELKESS

Kinetic Energy Storage

Velkess has recently demonstrated a novel flywheel technology that can provide economical grid scale energy storage.

Velkess's initial production will cost approximately 1/10th the price and run with 2x the efficiency of the best energy storage technologies available today.

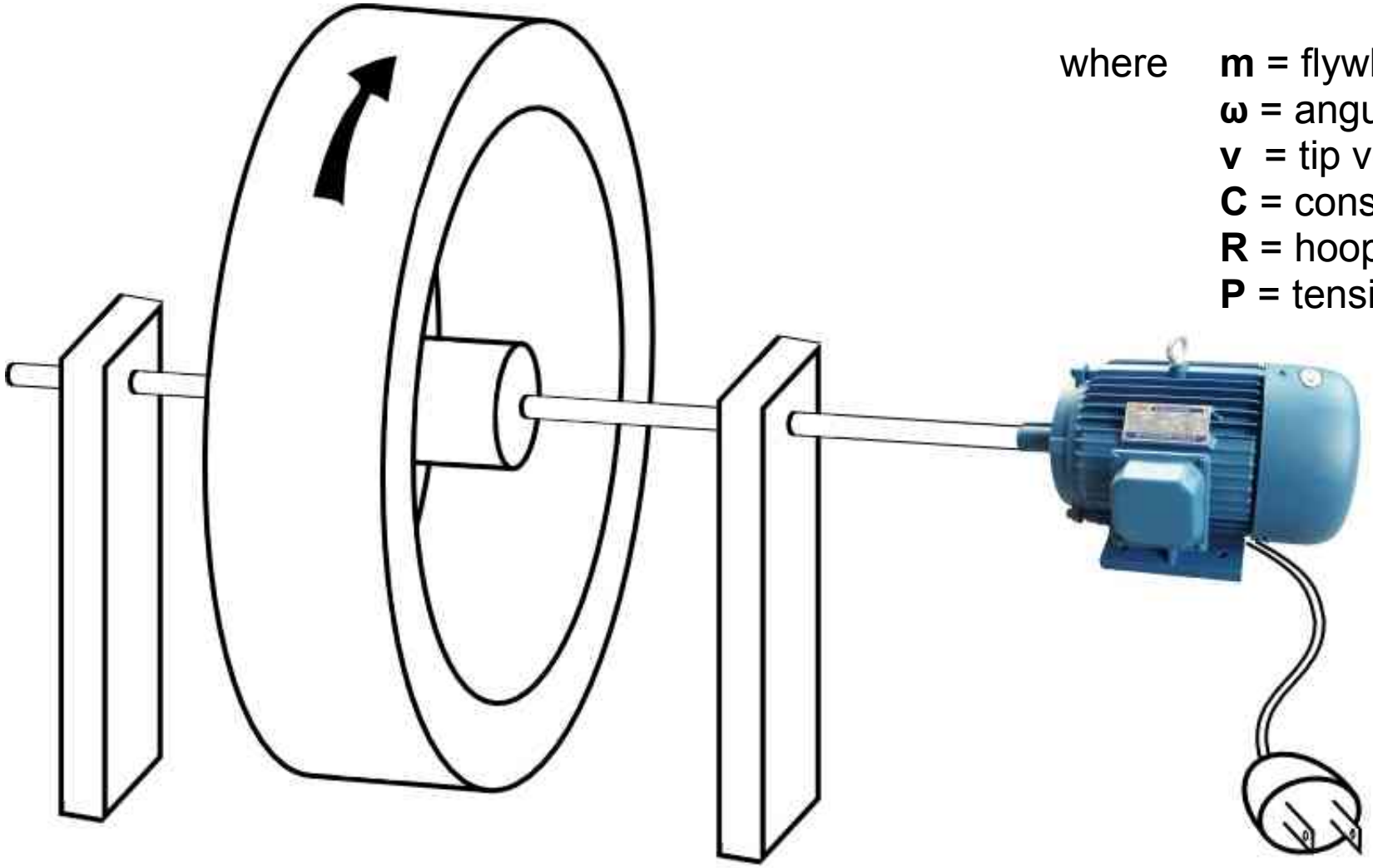
Velkess is currently working to commercialize this technology

Basic Flywheel Overview

$$E = \tfrac{1}{2} m v^2 = \tfrac{1}{2} m (\omega R)^2$$

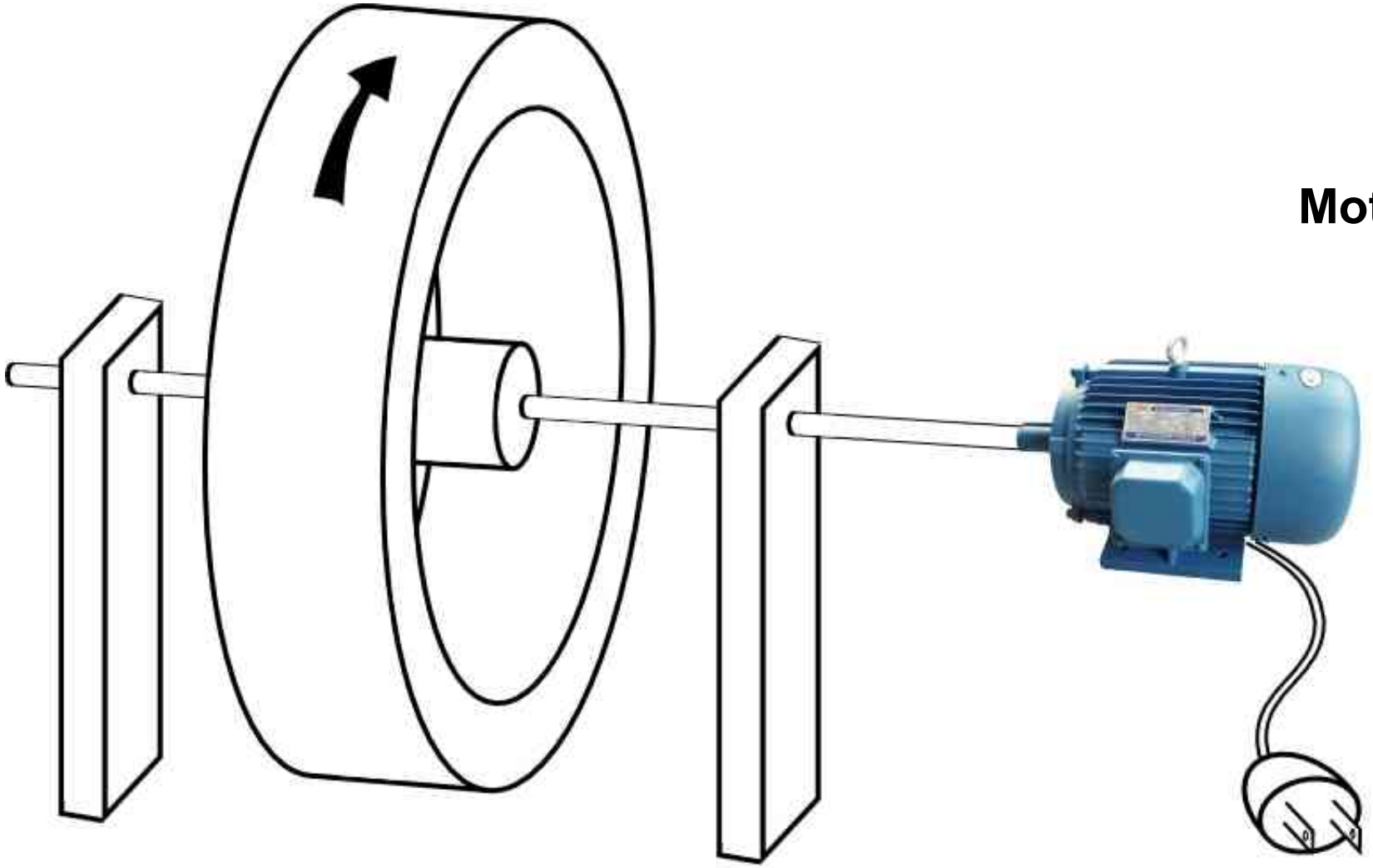
$$E_{max} = C * \pi R P_{max}$$

where **m** = flywheel mass
ω = angular frequency
v = tip velocity
C = constant
R = hoop mean radius
P = tensile stress in hoop



Primary Cost Areas for a Flywheel

Rotor
- **Materials**
- **Fabrication**



Motor Generator
- **Materials**
- **Fabrication**
- **Efficiency**

Velkess's Core Technologies Enable Radically Lower Cost While Preserving Excellent Efficiency and Performance

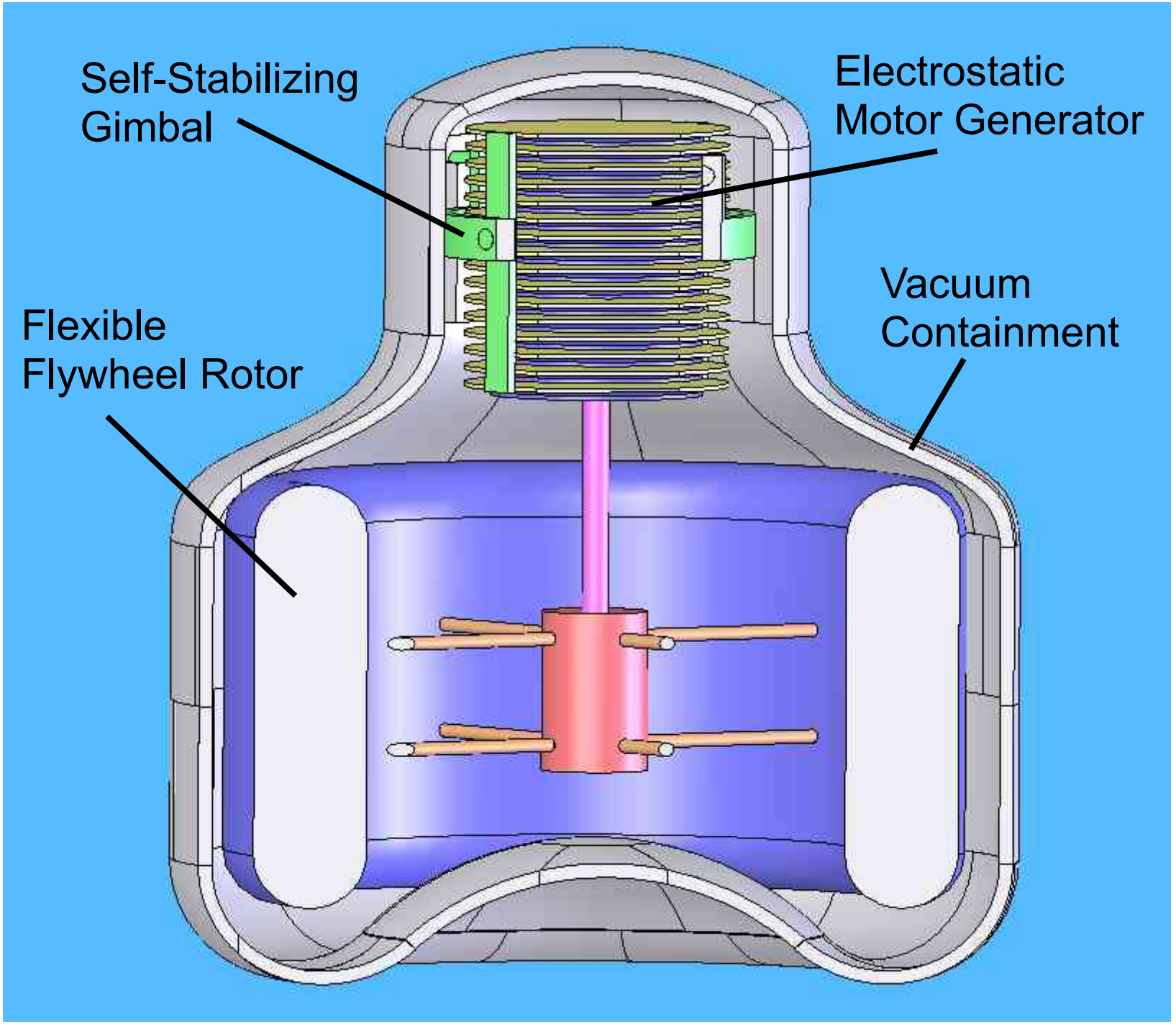
Self Stabilizing Flexible Flywheel Rotor System

- Dramatic Cost Reduction of Storage Medium
- Dramatically Lower Bearing Loading
- Inherent Stability = Safety
- Easy to Manufacture

Floating Rotor Electrostatic Motor Generator

- Extremely High Efficiency
- Very Low Cost
- Operates Natively on High Voltage
- Easy to Manufacture

Velkess Flywheel Energy Storage System



The Self Stabilizing Flexible Flywheel Rotor System

Operation based on principles first proposed by Dr. R.T. Schneider of NASA/Univ. of Florida. in 1975. First practicable design documented by Dr. John Vance and Dr. Brian Murphy in the late 1970's at Texas A & M.

Flexible flywheel achieves stability by accommodating natural rotor behavior. System not working under the “Rigid Body Assumption” that underpins traditional rotordynamic computational models.

Passive stability without active electronic components.

Dramatically lower bearing loading.

Eliminates “hoop stress” shear forces that limit traditional designs.

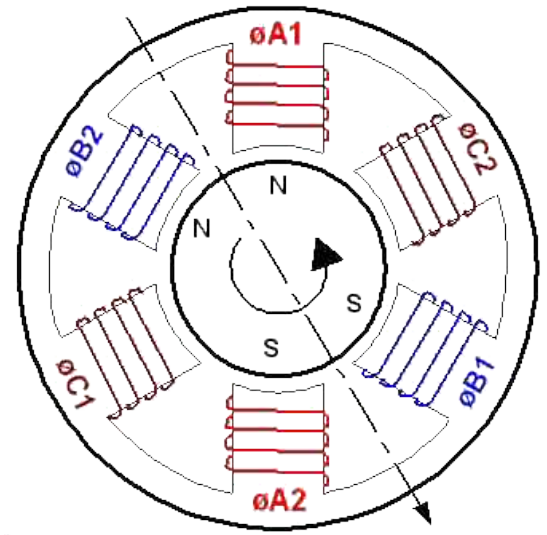
Can accommodate lower Young's Modulus (stretchy) materials.

Radically lower cost of materials and fabrication

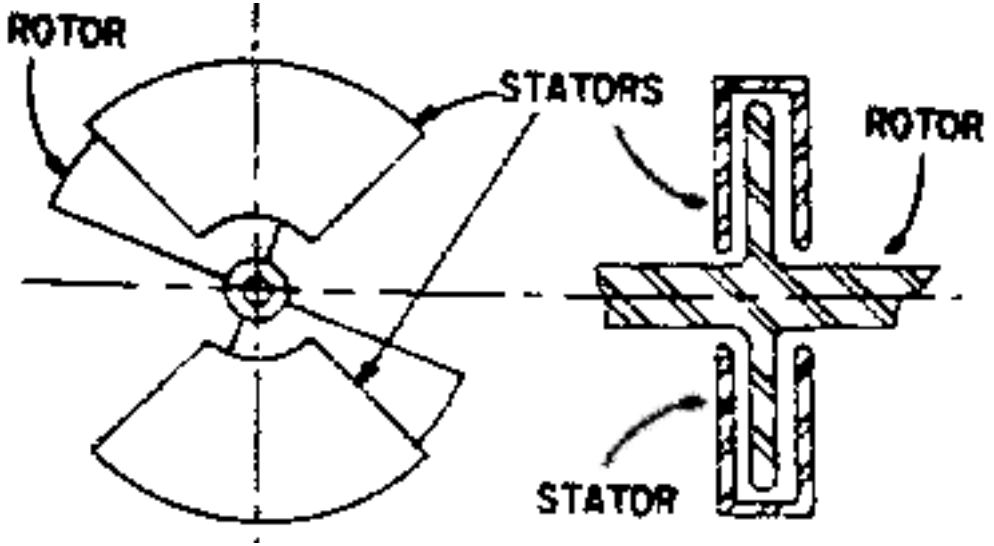

VELKESS
Kinetic Energy Storage Systems

Electric / Kinetic Energy Conversion

Electro*magnetic* Machine



Electro*static* Machine



Traditional Technology

High Power Density

Current Driven

High Efficiency Possible
(But at Very High Cost!)

Primary Materials: Copper & Iron

Older, But Little Used Technology

Lower Power Density

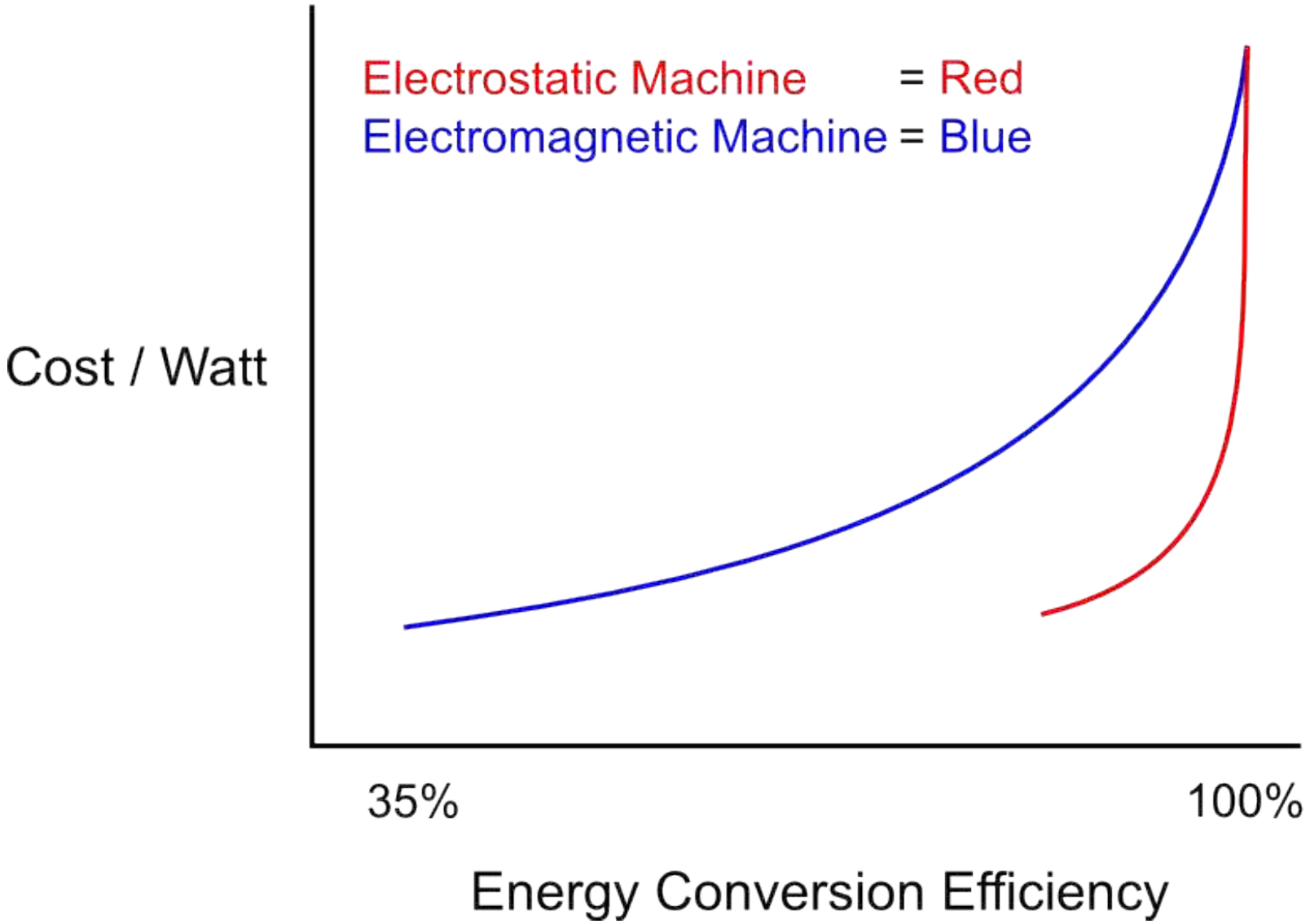
Voltage Driven

Inherently High Efficiency

Primary Materials: Ceramic or Plastic

Floating Rotor Electrostatic Motor Generator

Why not use a standard electromagnetic machine?



Floating Rotor Electrostatic Motor Generator

Floating Rotor Electrostatic Generator Originally Invented and Demonstrated by Dr. Sanborn Philp, Chief Physicist General Electric High Voltage Laboratory. First published in 1977.

- Natively High Voltage Device
- No Electrical or Physical Contact with Rotor
- Made Primarily of Low Cost Ceramic Materials
  - 1/200 the Cost of Copper
  - 1/50 the Cost of Silicon Iron
- Extremely High Efficiency
- Extremely Low “Parasitic Losses”
- Extremely Low Rotor Heating/Dissipation

Integrates with Transmission at Transmission Voltages. Does not Require Investment in Step-Down Electronics.

Together These Technologies Yield High Performance Energy Storage at Dramatically Lower Cost.

Current Projections for Energy Storage Using Current Technologies

= $2.5M – $3M / MW

Velkess Projected Initial Product Costs

= $300k / MW

Current Project Status

Working Demonstration Prototype

- Flexible Flywheel & Electrostatic Machine Working Together
- Medium Vacuum Environment (1E-5 Torr)
- Operating with 85% DC to DC efficiency

Development Stalled by Lack of Resources

Currently Seeking Funding to Develop...

- Grid Connected Demonstration System
- Engineering Team
- Initial Manufacturing

How Can You Help?

1) **Provide Guidance on How to Bring this Project to the Department of Energy for Demonstration Funding**

2) **Develop and Share an Informed Technical Opinion of the Project**

Thank you

For more information please visit...

www.velkess.com

or contact:

Bill Gray
CEO – Velkess Inc.
bill@velkess.com
415 407 7356

VELKESS
Kinetic Energy Storage